CHAPTER- III
RESEARCH METHODOLOGY

The quality and results of research work are dependents of the research methodology. Therefore, this is one of the important chapters of the thesis. In this RESEARCH METHODOLOGY chapter; the available information on net, e-books, magazines data collection sources and methods, the problems faced by earlier researchs and their analysis are considered.

During the process, the objective of this thesis evolved. The 1992 Latur and 2001 Bhuj earthquake the number of collapsed buildings was very high, as well as the human death toll entrapped init.

This demands the adequate and apt building buy-laws, development rules, regulations, and its implementation with full awareness by both regulating authority as well as by citizens, to reduce the number of collapsing buildings and thereby the fatalities, in the earthquake prone zones.

Significance of the study:-

To study of traditional methods and newly developed methods of retrofitting, for relative advantages and disadvantages.

Case studies to assess the residual strength of existing structure by performing 'Non-Destructive tests (NDT),' and suggest safest, economical, and eco friendly methods of retrofitting.

- To compare various methodologies of retrofitting of residential buildings, on principle of safety of occupant's life, live stocks and surrounding properties.
- Comparison: of: Eco friendly, economy, duration of execution, for different types, of constructions materials.
- To prepare guidelines, from the conclusions of the comparison.

Hypothesis:-
Ha-Safety of life of family and safe home from natural or otherwise calamities is always the first priority of residents. Majority of residents of Ahmadabad, Bhuj & Anjar residing in seismic Zone
III, IV & V are still staying in unsafe residential buildings, even today, after 13 years have passed earthquake of 26th Jan.2001.

Ho-All the residential buildings in Ahmadabad, Bhuj & Anjar and life of citizens residing therein, in seismic Zone III, IV & V, are safe and all the buildings are designed to cater the earthquake force as per BIS recommendations and therefore are not prone to collapse and therefore will not be the cause of fatial casualities, and termed as safe.

**Research Design:-**

The definition as stated and quoted from Business Dictionary [68] is: “A detailed outline of how an investigation will take place. A research design will typically include how data is to be collected, what instruments will be employed, how the instruments will be used and the intended means for analyzing data collected.” Data collected by interviewing the Senior Architects and Sr. Structural Designers, Builders, and Developers (with Experience >20 yrs. in the construction industry), Site Engineers (with Experience 10-15 yrs. in the construction industry), the bungalow, flat owners, construction contractors. All the interviewes were from seismic zones III, IV & V from Ahamdabad, Bhuj, Adipur, Gandhidham locations in Gujarat. The site engineers selected were with experience mainly after the 2001 earthquake, in order to asses the level of implemaintation of BIS code provisions. All other members selected were having more than 20 yrs in the field so that they account for both pre and post scenario of quake. Database developed from Collected Data by random Sampling method; this database was analysised and tested with ‘One tailed significance method of testing’.

**Research Area:-**

1) City of Ahemdabad, falling in seismic zone III, wherein about 75 multi-storeyed residential buildings collapsed in 2001’s earthquake.

2) City of Bhuj, the epicenter of the earthquake, falling in seismic zone V, wherein important building like Hospital, G+5 storeied residential buildings, and many old houses closely spaced in village area collapsed, with high number of casualties.
3) Cities of closely located to epicenter like Gandhidham, Adipur, falling in seismic zone V, wherein G+2-3 RCC buildings, bungalows, old houses, collapsed, for more than one or any specific reason. Few Buildings as old as 45 years or more survived, without significant damages.

**Research Arena:-**

The research problems need boundaries to define domain of scope, and limitations, they are:

A. To Study of traditional methods and newly developed methods of retrofitting, for their relative advantages and disadvantages.

B. To compare in respect of safety, economic and Eco friendly values of newly developed methods of retrofitting, and Traditional Methods.

C. The Process of “The Life cycle evaluation in respect of residential buildings”

D. Analysis of data collected and discussion about findings.

E. To ascertain the probable reasons for non-implementation or negligent attitude towards life safety of occupants, with the help of data collected.
Collection of Data:

To collect the information about an awareness and implementation of BIS Code's seismic specification and recommendations in existing or new residential buildings from:

1) Owners of the building,
2) Architects,
3) Structural engineers,
4) Building and Plan sanctioning authorities,

By method of Personal Interviews, Questioner.

Further to collect information, about the details of number of residential retrofitted buildings, the methodology adopted, from city of Ahmadabad and Bhuj, Gujarat, India

Representation of Data:-

The results are presented in graphs, tables, line diagrams.
1. General analysis

The citizens stay in houses constructed in six different types. RCC and Masonry cover almost 2/3 of the total number.

The performance level of buildings constructed under supervision of engineered, will be closer to the design parameters.

Performance level of non-engineered buildings may or may not comply, thus the safety of building and occupants is in dilemma.
The buildings constructed in schedule time will have even effect on the unit of natural elements and deterioration.

The parts / segments completed at different times with discontinuity of entire work, results in differential depletion rates.

The sanctioned buildings will be within, the buy-laws and area development rules and regulations.

Buildings constructed without sanctions will fall short in one or more laws, and or rules and regulations.
Sanctioned buildings can be insured.

Buildings, without sanction cannot be covered under insurance.

Buildings designed as per BSI code specifications covered under insurance.

There is no compulsion under law, for insurance of the building. Many occupants do not opt for coverage, for the reason additional financial burden, ignoring the safety.
Different Insurance companies have different terms and conditions.

Not insuring the building indicates negligence, overlooking, and or unawareness attitude of occupants.

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The subsidies and concessions were applicable only for those buildings recommended by the agency (a deemed University) appointed by GOG for evaluation of damages.

The subsidies and concessions were not applicable other buildings.

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The subsidies and concessions were not applicable to other buildings.

Not opting for structural auditing of the building indicate negligent, overlooking or unawareness of the occupants.

Opting for structural auditing of the building shows awareness about safety by the occupants.
Not opting for frequent structural auditing of the building indicate negligent, overlooking or unawareness of the occupants.

Opting for frequent structural auditing of the building shows awareness about safety by the occupants.

Proper maintenance extends serviceable life of the building.

Non-compliance indicates negligent attitude, majorly for additional financial burden.
Analysis of data from Current owner/s

Houses or buildings constructed in five types.

Buildings constructed prior to E.Q. and have stood the impact, indicate they were designed as per BIS code, the use of good quality material and workmanship.

The newly constructed buildings, having proper sanction complying BIS code can withstand calamity, if any, in future.
Safe occupants through the safety of building and tremors, proves life of occupants.

Not enquiring about the safety of building indicates unawareness or need to occupy at the cost of safety.

Enquiring about the safety of building indicates level of unawareness of occupants.
The majority of occupants give less importance to periodic maintenance.

The maintenance done when problem crops up and acquire high damage level, increases the repair/retrofitting cost as well as reduces the life and safety of structure.

Observance of no damages indicates adequate designing, better workmanship, and use of good quality material.

Observance of damages indicates inadequate designing, poor workmanship, use of bad quality material, and inapt maintenance.
Occupants do not complain and the problem engraves.

No damages observed prior to tremors made buildings stood the tremors.
Singly owned building owners consult the major defects with Architects or structural engineers immediately.

In cooperative ownership, it is dilly-dallyed.
Analysis of Data from Sr. Architects/ Sr. Structural Engineers /Site Engineers:-

Interviewees:
- Site engineers with experience > 15 yrs.
- Arch. & Structural eng. With experience > 15 yrs.

Professionals designed majority of buildings.
They did not collapse.
Majority designers were aware of BIS code specifications and recommendations. Others negligent, overlooking, or unaware about BIS code specifications and recommendations.

The terms of reference of agreement between the Owner/Developer/Builder and the professionals were either with or without supervision. Yes= With Supervision. No=Without Supervision.
**Stricter Supervision:**
Yes = Awareness about Quality of construction.
No = Either not supervised as per terms of agreement or lenient and casual about Quality of construction.

**Observing building post E.Q.:**
Yes = Caring and conscious about own work.
No = Not Bothered about own work, post completion of construction of Building.
Estimation:

- **100% - 61%**: - Safe Designing of the building
- **60% - 31%**: - The reason for damage may be designing done pre-revision of BIS code or inadequate design, modifications to building post construction.
- **30% - 0%**: - Designed

Being in the team:

- **No**= Not fitting in Experience criteria or not interested in rehabilitation works.
- **Yes**= Fitting in Experience criteria and interested in rehabilitation works.
Evaluation: -

Yes=Retrofitting work undertaken past post E.Q. after tremors period.

No=Retrofitting work undertaken during E.Q. after tremors period, to safeguard the building.

Periodic visits post completion of Rehab work: -

- Yes= Concerned about quality of own work.
- No=Not Concerned about quality of own work.
Changes: -
- Yes= Professional having Experience > 15 yrs.
- No= Professional having Experience > 15 yrs and therefore unaware about the changes.

Satisfaction about changes: -
- Yes: - Confident about own work and its implementation.
- No: - Expect cross checking of the design by concerned authorities.